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BULLETIN OF THE MARINE BIOLOGICAL STATION OF ASAMUSHI,
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FAUNA OF SHELL-BEARING MOLLUSKS IN MUTSU BAY LAMELLIBRANCHIA (1)[1)]

By

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(With 5 plates)

The fauna of Mollusca in Mutsu Bay have been investigated by three authorities in the series of the Biological Survey of Mutsu Bay conducted by the late Dr. Sanji Hôzawa since 1926. They are Takatsuki (1927), Baba (1935) and Is. Taki (1938) on shell-bearing mollusks, nudibranchs and chitons respectively. As to shell-bearing mollusks 74 species were listed up by Takatsuki: 36 species of lamellibranchs and 38 species of gastropods. Thereafter, Nomura and Hatai have published in Japanese a list of shell-bearing mollusks containing 85 species of lamellibranchs, 3 species of scaphopods and 65 species of gastropods collected in the bay (1932).

As the present writers have collected the shell-bearing mollusks with the helpful assistance of the members of the Marine Biological Station of Asamushi recently, species with high populations, and the distribution and habitats of the common species in the bay have been clarified. Therefore, the present reports were undertaken to throw further light on the fauna, distribution and habits of mollusks in the bay, and, in addition, on the specific characters of these shells with brief descriptions and illustrations, although it may not be expected that the number of species exceeds much that of Nomura and Hatai's collection. Especially, in this collection, a great care was taken to comprise all of the species having high population in the bay.

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1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 234.

the collection in the bay and for providing the materials collected by themselves. Acknowledgements are also due to the Foundation in Support of the Marine Biological Station of Asamushi, Tôhoku University, for the grant received.

Class LAMELLIBRANCHIA
Subclass PRIONODESMACEA
Order LIPODONTA (PALEOBRANCHIA, PALEOCONCHA)
Family SOLEMYIDAE

1. *Solemya* (*Acharax*) *japonica* Dunker (Pl. II, Figs. 1, 2)

Japanese name : Asahi-kinutare-gai

Solemya japonica Dunker 1882, p. 220, 261, Pl. 14, Fig. 3; Kira 1954, Pl. 41, Fig. 1.
Solemya yamakawai Yokoyama 1927, p. 435, Pl. 50, Figs. 10, 11.

This small solemyid species has a shell covered by a vernicose brownish periostracum on which many pale yellowish threads radiate. The ligament is external, at the short posterior dorsal margin. By this feature this species belongs to the subgenus *Acharax* and differs from the nearest ally *S.* (*Petrasma*) *pusilla* Gould (Pl. II, Figs. 3, 4), which has been reported from Hakodate, in the southernmost part of Hokkaido, and whose ligament sinks internally.

Locality : Off Ushirogata, Kobashi, Kugurizaka, Noheji, Ominato and St. 20.

Distribution : The Pacific coast of Honshu and Kyushu.

Habitat : This species is rather common in the shallow waters on the muddy bottom.

Order PROTOBRANCHIA
Family NUCULIDAE

2. *Acila* (*Truncacila*) *insignis* (Gould) (Pl. II, Fig. 6)

Japanese name : Kirara-gai

Nucula (*Acila*) *insignis* Gould 1861, p. 36; Nomura et Hatai 1932, p. 2.

This is characteristic in having a divaricate sculpture on the surface of shell, which is covered by a thick periostracum colored yellowish black. The interior of shell is pearly and at the dorsal margin expose many teeth and a oblique chondrophore beneath the umbo. This is included in the subgenus *Truncacila* in lacking the ear-like process at the posterior end of the dorsal margin.

Locality : Off Kanita, Ushirogata, Moura, Futago, Asadokoro, Noheji, Arito, Hamaokunai, Kawauchi, Shukunobe and St. 16.

Distribution : Northern Honshu and Hokkaido.

Habitat : This species has a wide vertical range from the lower tide mark to the deep sea of about 200 m on the fine sandy bottom.

Family NUCULANIDAE

3. *Nuculana* (*Thestyleda*) *yokoyamai* Kuroda (Pl. II, Fig. 8)

Japanese name : Arabori-robai

Leda ramsayi Yokoyama (non Smith) 1920, p. 176, Pl. 19, Fig. 3.
Nuculana (*Thestyleda*) *yokoyamai* Kuroda 1934, p. 204.

This small species is quite separable from other Japanese nuculanids in having a distinct undulation all over the shell surface, by which character this allocates in the subgenus *Thestyleda*. The shell narrows into a slightly recurved rostration posteriorly.

Locality : Off Moura and Sts. 7 and 22.

Distribution : Kyushu to Honshu.

Habitat : This is rather common species on the continental shelf around Japan.

4. *Cnesterium johanni* (Dall) (Pl. II, Fig. 5, Pl. IV, Fig. 1)

Japanese name : Ezo-sode-gai

Yoldia johanni Dall 1925, p. 32, Pl. 29, Fig. 7; Kira 1954, Pl. 41, Fig. 13.

This is characteristic in having, on the middle part of shell-surface which is covered by a vernicose yellowish black periostracum, oblique striae, which are not marked along the growth lines. The shell is thin and its interior is white, not pearly. The nearest ally *C. notabile* (Yokoyama) attains a larger size in the adult, exceeding 40 mm in length and its shell possesses the oblique striae all over the surface.

Locality : Off Moura and Sts. 21 and 22.

Distribution : Northern Honshu and Hokkaido.

Habitat : This is a mud dweller of shallow waters. Commonly found in this bay.

5. *Cnesterium notabile* (Yokoyama) (Pl. IV, Fig. 5)

Japanese name : Furisode-gai

Yoldia notabilis Yokoyama 1922, p. 196, Pl. 17, Fig. 10; Takatsuki 1927, p. 20, Kira 1954, Pl. 41, Fig. 12.

This species was reported by Takatsuki, but we have not yet obtained any specimen from this bay.

Locality : Off Yomogida.

Distribution : Northern Honshu and Hokkaido.

Order TAXODONTA (FILIBRANCHIA)

Family ARCIDAE

6. *Arca boucardi* Jousseaume (Pl. IV, Fig. 6)
Japanese name : Kobelt-fune-gai

Arca boucardi Jousseaume 1894, The Humming Bird, 4, Fig. 14; Takatsuki 1927, p. 20; Nomura et Hatai 1932, p. 2; Is. Taki 1951, Pl. 2, Fig. 1; Kira 1954, Pl. 42, Fig. 15.
Arca kobeltiana Pilsbry 1904, p. 559, Pl. 40, Figs. 16–19.
Atca rectangularis Tokunaga 1906, p. 61, Pl. 3, Figs. 23a-c.

This ark shell, having many ribs and covered by the hairy periostracum all over the surface, is purplish in color. On the wide and flat ligamental area between the umbones are prominent chevron-shaped ligamental grooves. The dorsal hinge line is straight and bears many small teeth. This species is easily distinguished from *Arca navicularis* which is very common in Southern Japan in having an oblique truncation posteriorly, not excavated in the middle. *Arca arabica* is an allied form, but the shell covered by yellowish hairs is smaller in the adult and shorter in length than this species.

Locality : Off Aburakawa, Nonai, Asamushi, Yunoshima, Tsuchiya, Moura, Mourashima, Futago-jima, Oshima, Asadokoro, Karibasawa, Noheji, Yokohama, Ominato, Kawauchi and Kozawa.

Distribution : Formosa to Hokkaido, especially common in Northern Japan.

Habitat : This species lives under rocks lower than the tide mark, and also on the fine sandy bottom, attaching by the byssus. This is sometimes collected by dredge for food by the inhabitants along the shore of this bay. The bivalve has showed a great fluctuation in its population in the bay.

7. *Arca arabica* Philippi (Pl. IV, Fig. 2)
Japanese name : Neji-asari

Arca arabica Philippi 1847, p. 28, Pl. 4, Fig. 2 Nomura et Hatai 1932, p. 3; Is. Taki 1951, Pl. 1, Fig. 9; Kira 1954, Pl. 42, Fig. 7.

This species has never been collected by the authors, while Nomura and Hatai reported this from this bay.

Locality : Yunoshima and Asamushi.

Distribution : Widely distributes in the southern seas, up to Honshu.

Habitat : This adheres to rock by the byssus.

8. *Arca miyatensis* Oyama (Pl. II, Figs. 17, 18)
Japanese name : Kitano-fune-gai

Arca kobeltiana Yokoyama (non Pilsbry) 1920, p. 163, Pl. 17, Fig. 4.
Arca miyatensis Oyama 1951, p. 155; Habe 1955, p. 3, Pl. 3, Figs. 1, 3.

This is smaller than *A. boucardi* in the adult despite of the close resemblance in shape, and the shell is colored blackish yellow and has bifurcate thick radial ribs on the postero-dorsal area. The ligamental area is restricted to the anterior half

of the rhomboidal area between the umbones.

Locality : St. 18.

Distribution : Northern Honshu and Hokkaido.

Habitat : This is found in the deeper bottom than *A. boucardi*.

9. *Pseudogrammatodon dalli* (Smith) (Pl. II, Fig. 24)

Japanese name : Shikoro-e-gai

Arca (*Macrodon*) *dalli* Smith 1885, p. 269, Pl. 17, Figs. 10, 10b.
Parallelodon obliquatus Yokoyama 1920, p. 170, Pl. 18, Figs. 9–11.
Cucullaria dalli obliquata Nomura et Hatai 1932, p. 3.
Pseudogrammatodon dalli Kira 1954, Pl. 42, Fig. 10.

This is similar to *Barbatia lima* (Reeve) of the south in the shell appearance. But the arrangement of teeth on the cardinal plate distinctly differs between them. In this species, the teeth arrange horizontally, not vertically as in that species. This feature is quite characteristic.

Locality : Asadokoro, Gomejima, Asamushi and St. 23.

Distribution : Kyushu to southern Hokkaido, and Korea.

Habitat : This lives on submarine rocks, attaching by the byssus.

11. *Anadara* (*Scapharca*) *broughtonii* (Schrenck) (Pl. V, Fig. 3)

Japanese name : Aka-gai

Arca inflata Reeve (non Schroeter) 1844, sp. 30; Takatsuki 1927, p. 20; Nomura et Hatai 1932, p. 3.
Acra broughtoni Schrenck 1867, p. 578, Pl. 24, Figs. 1–3; Is. Taki 1951, Pl. 3, Fig. 4; Kira 1954, Pl. 43, Fig. 14.
Arca tenuis Tokunaga 1907, p. 58, Pl. 4, Figs. 1a, b.

This is one of the important edible mussels in Japan. This species has radial ribs on the rather thin shell, the number of which is about 42. Therefore it is easily separable from the nearest ally *A. satowi* (Dunker) of about 37 ribs. The latter species moreover has a thicker shell on which the broader and higher radial ribs are present, resembling *A. subcrenata*.

Locality : Off Aburakawa, Aomori, Nonai, Kugurizaka, Asamushi, Yuno-shima, Gomejima, Moura, Asadokoro, Ominato and St. 15.

Distribution : Kyushu to southern Hokkaido.

Habitat : This is a dweller of the muddy bottom in the deep of this bay. The fishing of the mussel is carried out at the center of the eastern part of the bay, especially near Sts. 9 and 23. The population fluctuates much periodically.

12. *Anadara* (*Scapharca*) *subcrenata* (Lischke) (Pl. IV, Fig. 4)

Japanese name : Sarubo or Mo-gai

Arca subcrenata Lischke 1869, p. 107.

Arca nodosocrenata Lischke 1869, Pl. 9.
Arca kagoshimensis Tokunaga 1906, p. 59, Pl. 3, Figs. 21a, b.

This is also an important edible mussel in Japan. The culture of this species is made in inland seas of Japan such as Nakanoumi, Kojima Bay and Tokyo Bay. The shell is thick and white on whose surface about 28 ribs are radiated and a brownish black-colored periostracum lies. In the left valve the ribs are granulated at the summit. *Anadara japonica* Reeve, that has a somewhat elongate shell ventrically, is perhaps a local form of this species.

Locality : Off Tsuchiya.

Distribution : Ryukyus to Honshu.

Habitat : In the young stage this species attaches to the leaves of eel-grass, so that it is called "mogai", meaning the mussel dwelling on sea grasses. But in the adult stage this lives on the muddy bottom in shallow waters of bays. This species is rather uncommon in this bay, but sometimes the young may be found.

13. *Anadara* (*Scapharca*) *troscheli* (Dunker) (Pl. IV, Fig. 3)
Japanese name : Hime-aka-gai

Scapharca troscheli Dunker 1882, p. 234, Pl. 14, Figs. 14, 15.
Arca troscheli Nomura et Hatai 1932, p. 3.
Anadara (*Scapharca*) *troscheli* Kira 1954, Pl. 43, Fig. 5.

This has a thick shell with about 24 radial ribs and a hairy periostracum. We have never seen this species in the bay, while Nomura and Hatai had reported it.

Locality : Kugurizaka.

Distribution : Kyushu to Honshu.

Habitat : The species lives in the eel grass field of the intertidal zone.

14. *Striarca* (*Galactella*) *symmetrica* (Reeve) (Pl. II, Figs. 19, 20)
Japanese name : Mimi-e-gai

Arca symmetrica Reeve 1844, p. 117; Nomura et Hatai 1932, p. 3.
Striarca symmetrica Is. Taki 1951, Pl. 2, Fig. 5.

This is a small ark shell with a diamond ligamental covering between umbones. The surface sculpture consists of many radial ribs crossed by weak growth lines.

Locality : Futagojima. Kanita and Yunoshima.

Distribution : Philippines to Japan, up to Mutsu Bay.

Habitat : This shell lives under stones along the coast between tide marks.

Family GLYCYMERIDAE

15. *Glycymeris yessoensis* (Sowerby) (Pl. II, Figs. 25, 26, Pl. IV, Fig. 8)
Japanese name : Yezo-tamaki-gai

Pectunculus yessoensis Sowerby 1888, p. 570.

Glycymeris yessoensis Takatsuki 1927, p. 20; Nomura et Hatai 1932, p. 2; Kira 1954, Pl. 44, Fig. 10.

The shell is thick and brownish outside and white inside, and its surface is sculptured with stripes and grooves alternately. The ventral margin is strongly crenulated. This approaches to the deep sea species *G. rotunda*, but the shell of this species is covered by a rough periostracum.

Locality: Off Kanita, Ushirogata, Aburakawa, Aomori, Kugurizaka, Asamushi, Yunoshima, Oshima, Higashitazawa, Asadokoro, Noheji, Yokohama, Ominato, Kawauchi, Wakinozawa and Sts. 5 and 17.

Distribution: Northern Honshu and Hokkaido.

Habitat: This is found on the fine sandy bottom in shallow waters.

16. *Limopsis tajimae* Sowerby (Pl. II, Figs. 22, 23)
Japanese name: O-shirasuna-gai

Limopsis tajimae Sowerby 1914, p. 445, Pl. 18, Fig. 3; Takatsuki 1927, p. 20; Is. Taki 1951, Pl. 1, Fig. 3; Kira 1954, Pl. 44, Fig. 2.

This species has been reported by Takatsuki from this bay, but the writers have collected no specimen until to-day. The shell has a smooth surface densely tufted with hairs. The genus *Limopsis* somewhat resembles the genus *Glycymeris* in the shell appearance, but the ligament of the former is small and central, and triangular in shape.

Locality: Off Okunai.

Distribution: Kyushu to Honshu.

Habitat: This is a deep sea shell dwelling on the muddy bottom.

Order DYSODONTA (ANISOMYARIA)
Family MYTILIDAE

17. *Modiolus difficilis* (Kuroda et Habe) (Pl. III, Figs. 1, 2)
Japanese name: Ezo-hibari-gai

Volsella difficilis Kuroda et Habe 1950, p. 30; Is. Taki 1951, Pl. 18, Fig. 9; Kira 1954, Pl. 45, Fig. 21.

Modiolus capax Takatsuki (non Conrad) 1927, p. 21; Nomura et Hatai 1932, p. 4

Modiolus modiolus Nomura et Hatai (non Linné) 1932, p. 4.

This species was formerly confused with the European *Modiolus modiolus* or with the American *M. capax* by its shell appearance so closely resembling. But, on the postero-dorsal area the shell has simple but long and strong bristles on the periostracum, that of the remaining area being smooth and vernicose. These features may distinguish this species from the two confused species. It exceeds 10 cm in length and loses the bristles on th surface in older specimens. Though *Volsella* Scopoli 1777 had generally been in use, the International Commission

of Zoological Nomenclature made a suspension of the rules and accepted *Modiolus* Lamarck 1801 as a *nomina conservanda* in Opinion 325 in 1955.

Locality : Off Aburakawa, Asamushi, Yunoshima, Gomejima, Moura, Oshima Asadokoro, Karibasawa, Noheji, Yokohama and Sts. 5, 6 and 18.

Distribution : Northern Honshu (down to Tokyo Bay), Hokkaido, Saghalien and Kuriles.

Habitat : This is the commonest horse mussel in this bay below the low water mark to the muddy bottom. Collected for food by dredging.

18. *Modiolus nipponicus* (Oyama) (Pl. IV, Fig. 11)

Japanese name : Hibari-gai

Volsella nipponica Oyama 1950, p. 1; Is. Taki 1951, Pl. 18, Fig. 6; Kira 1954, Pl. 45, Fig. 16.

Modiolus barbatus Nomura et Hatai (non Linné) 1932, p. 4.

This is a species confused with the European *M. barbatus*, but the shell is rather thin and smaller, with about 4 cm in length in the full-grown specimen, and is marked with a reddish broad zone on the middle part, the dorsal and ventral parts being brownish and covered by the periostracum with serrated bristles except the rather narrow but vernicose antero-ventral area. This somewhat resembles *M. plumescens* Dunker from Southern Japan but the ventral margin of this species is not twisted but gaped.

Locality : Asamushi, Moura, Karibasawa, Noheji and St. 10.

Distribution : Formosa to Honshu and Korea.

Habitat : Uncommon in this bay. This species attaches to rocks under the low tide mark with its byssus.

19. *Modiolus* (*Modiolusia* n. subgen.) *elongatus* (Swainson) (Pl. III, Fig. 22, Pl. IV, Fig. 20)

Japanese name : Tsuya-garasu

Modiola elongata Swainson 1821, Exot. Conch., 1, Pl. 8.

This is quite separable from the preceding two species in having vernicose periostracum all over the shell which gently increases in height posteriorly.

Lamy placed this species in the subgenus *Modiolatus* of this genus and Habe followed this view. But Soot-Ryen states this subgenus has *Mytilus plicatus* Chemnitz as its type under the original designation but it does not seem to be a Mytilid. Therefore for the group of *Modiolus elongatus* a new subgeneric name *Modiolusia* is introduced, the type of which being this species as follows :

Subgenus *Modiolusia* nov.

Type species : *Modiolus elongatus* (Swainson)

Shell rather large, thin, elongate, increasing in height posteriorly, inflated

ventrally, the posterior area being flattened; the anterior margin little produced before the umbo and the posterior sloping obliquely from the dorsal margin which is long and straight; the ventral is also nearly straight, but in some species a slight concavity in the middle; the surface smooth and shining, covered with a chestnut brown periostracum; an obtuse ridge runs from the umbo to the postero-ventral corner, becoming obsolately: the interior smooth and pearly; the hinge line very long, occupying four fifths of the dorsal margin no denticulation presents on the margins.

The species of this new subgenus live in mud or fine sand and spin nests of mud particles and fine byssal threads.

Modiolus hanleyi reported by Takatsuki and by Nomura and Hatai may be the misidentification of this species as they did not report this species which is rather common in this bay.

Locality: Sts. 8 and 9.

Distribution: Siam Bay to Japan (north to this bay).

Habitat: It lives in the muddy bottom forming a nest of gelatinous mass in shallow waters.

20. *Modiolus* (*Modiolusia*) *hanleyi* (Dunker)
Japanese name: Hanley-hibari-gai

Modiola hanleyi Dunker 1882, p. 223, Pl. 16, Figs. 3, 4.
Modiolus hanleyi Takatsuki 1927, p. 21; Nomura et Hatai 1932, p. 4.

This species from this bay as already stated above may be the preceding species.

Locality: Off Asamushi and Yunoshima.

Distribution: Kyushu to Honshu (up to Wakayama Prefecture).

21. *Musculus* (*Musculista* n. subgen.) *senhousia* (Benson) (Pl. II, Fig. 13)
Japanese name: ototogisu-gai

Modiola senhousia Benson 1842, p. 489.
Brachidontes senhousia Nomura et Hatai 1932, p. 4; Is. Taki 1951, Pl. 18, Fig. 1; Kira 1954, pl. 45, Fig. 1.
Modiola bellardiana Tapparone-Canefri 1874, p. 144 Pl. 4, Figs. 4, a, b.

This thin shell has narrow, reddish colored, radial bands on the postero-dorsal area and rather distinctly marked, radial cords on the antero-ventral area, the area between them being smooth and polished. This manner is more like the genus *Musculus* than the genus *Brachidontes* as Soot-Ryen said. Habe considered that this belongs to the *Arcuatula*, the type of which is *Modiolus arcuatula* by tautonymy as a subgenus of *Brachidontes*. But according to Soot-Ryen, the type species of this subgenus is not *Modiolus arcuatula* but *M. plicatula* which is the same as

M. demissa Dillwyn under the original designation. This type species is quite unlike *"Brachidontes" senhousia*. Therefore, for this species, a new subgeneric term *Musculista* is proposed, together with *M. perfragilis* and *M. japonica* both by Dunker, designating this species as the type, as follows :

Subgenus *Musculista* nov.

Type species : *Musculus senhousia* (Benson)

Shell medium sized, thin, ovate to elongate-ovate, rather inflated umbo from the anterior end to a little posterior and slightly elevated on the dorsal line the anterior margin rounded and the posterior sloping obliquely from the rather straight dorsal margin, the ventral margin nearly straight the surface marked only by lines of growth, but in the type specimen, several cords radiate from the umbo to the antero-ventral margin, causing the crenulations at their distal ends, and covered with a smooth and shiningly greenish periostracum, variegated with brown fulguration of all over and with brown radiating striae on the posterior dorsal portion the interior smooth and bluish white the ligament extends from the umbo posteriorly for a half of the dorsal margin, on the rest of which minute denticulations bear.

That this species is transferred from the *Brachidontes* to the *Musculus* is a more natural classification, because this secretes a nest of mud held together by the byssal threads.

Locality : Off Ushirogata, Asamushi, Kugurizaka and Ominato.

Distribution : China to Hokkaido; also Korea and Maritime Prov. of Siberia.

Habitat : This species lives on the muddy bottom in the tidal zone and under the lower tide mark in shallow waters and builds a nest made of mud and byssal threads. This is one of the indicator species of rather stagnant bottom waters.

22. *Musculus* (*Modiolarca*) *neglectus* Kuroda (Pl. II, Fig. 7)

Japanese name : Tama-e-gai

Musculus neglectus Kuroda 1941, p. 196; Is. Taki. 1951, Pl. 19, Fig. 7; Kira 1954, Pl. 45, Fig. 6.

Musculus cumingiana Takatsuki (non Reeve) 1927, p. 21.

This is characterized by an inflated shell with three distinct areas on the surface, the two being radially sculptured at the ends and with a median smooth area. Takatsuki reported this species from this bay, but no specimen is present in our collection.

Locality : Mourakojima.

Distribution : Southern Honshu (north to Sagami and Noto).

Habitat : This species is embedded in the test of ascidian species such as *Pyura vittata* (Stimpson) (*Cynthia karasboja* Oka) at the low tidal level.

23. *Lithophaga* (*Leiosolenus*) *curta* (Lischke) (Pl. II, Fig. 12, Pl. V, Fig. 6)
Japanese name : Ishi-mate or Ishi-wari

Lithophagus curtus Lischke 1874, p. 111, Pl. 9, Figs. 14–17.
Lithophaga curta Takatsuki 1927; Nomura et Hatai 1932, p. 4; Is. Taki. 1951, Pl. 19, Fig. 5; Kira 1954, Pl. 45, Fig. 11.

The surface of this cylindrical shell is smooth with a thin calcareous incrustation. No specimen was collected by us.

Locality : Tsuchiya, Futagojima and Aburamesaki.

Distribution : Ryukyus to Honshu (up to this bay).

Habitat : This species bores corals and other shells.

24. *Mytilus edulis* Linné (Pl. III, Figs. 7, 8)
Japanese name : Murasaki-igai

Mytilus edulis Linné 1758, p. 704; Is. Taki 1951, Pl. 17, Fig. 3; Kira 1954, Pl. 45, Fig. 19.

This is a thin and smooth shell colored purplish black, but sometimes brownish at the ventral area. This may be distinguished from the following two species in having two or three teeth just inside the umbo and no denticulation at the ventral margin.

Locality : Off Kanita, Ushirogata, Aomori, Nonai, Kugurizaka, Asamushi, Tsuchiya, Moura, Noheji, Yokohama, Ominato, Kawauchi, Wakinozawa and St. 6.

Distribution : The first record of collecting this introduced species in Japan has been made by Kanamaru at the Kobe harbor on 1934. Therefore, this species was not found in both Takatsuki's and Nomura and Hatai's papers.

Habitat : This species is gregarious at the intertidal zone on rocks or pilings, associated with *M. crassitesta* under the strata of *Septifer virgatus*. Also dense populations are found on set nets recently. It seems that this mussel became to populate commonly the bay in about 1948.

25. *Mytilus crassitesta* Lischke (Pl. IV, Fig. 15)
Japanese name : Igai

Mytilus crassitesta Lischke 1868, p. 221; Nomura et Hatai 1932, p. 3; Is. Taki 1951, Pl. 17, Fig. 5; Kira 1954, Pl. 45, Fig. 20.
Mytilus dunkeri Lischke (non Reeve) 1869, p. 153, Pl. 10, Figs. 7, 8; Takatsuki 1927, p. 21.

This is a native mytilid, dwelling on rocks in the intertidal zone or under the low tide mark. At Asamushi, this species is associated with the preceding species, and they are very difficult to identify the two species in the young stage as they are too alike in shape and coloration. But this species has a thick shell even in the young stage, covered by the vernicose periostracum, black zones alternating

with brown ones along the growth lines. The about three hinge teeth are strong and several minute crenulations are present at the ventral margin near the apex.

Locality : Nonai, Asamushi, Kugurizaka and Futagojima.

Distribution : Kyushu to Southern Hokkaido and Korea.

Habitat : Cited in the preceding species. This species prefers rather off shore waters.

26. *Mytilus* (*Crenomytilus*) *grayanus* Dunker (Pl. IV, Figs. 14, 19)

Japanese name : Ezo-igai

Mytilus grayanus Dunker 1853, p. 84; Nomura et Hatai 1932, p. 3; Is. Taki 1951, Pl. 17, Fig. 4; Kira 1954, Pl. 45, Fig. 22.
Mytilus coruscus Gould 1861, p. 38.

This was frequently confused with the preceding species by Japanese authors but may be easily distinguished from the latter in having at the antero-ventral margin a longer series of minute crenulations as the endings of minute stripes on the surface which is covered by a olivaceous blackish periostracum.

The shell is thick, not elongate in shape as in *M. crassitesta* and the muscle scars impressed strongly are larger than those of the preceding two species.

On the basis of those features the genus *Crenomytilus* was created for this species by Soot-Ryen in 1955, but we use this term as the subgeneric rank of the genus *Mytilus*, because *M. crassitesta* shows a intergradation between *M. edulis* and *M. grayanus* in the crenulation at the margin.

Locality : Asamushi, Moura, Noheji, Yokohama and Sts. 4, 7, 8 and 19.

Distribution : Kuriles, Hokkaido and Northern Honshu.

Habitat : This dwells on rocks below the low tidal level attaching by byssus. This prefers rather more deeper waters than *M. crassitesta* does.

27. *Trichomya hirsuta* (Lamarck) (Pl. III, Figs. 5,6, Pl. IV, Fig. 17)

Japanese name : Kegai

Mytilus hirsutus Takatsuki 1927, p. 21.
Trichomya hirsuta Is. Taki 1951, Pl. 17, Fig. 6; Kira 1954, Pl. 45, Fig. 15.

This is characteristic in having long hirsutes on the surface, on which many ribs radiate from the terminal umbo all over. As a result of this feature, the margin is distinctly crenulated. We have no specimen from the bay.

Locality : Tsuchiya.

Distribution : Northern Australia to Japan. Probably this bay is the northern-most locality of this species.

Habitat : This attaches by a byssus in masses to rocks in the intertidal zone.

28. *Septifer* (*Mytilisepta*) *virgatus* (Wiegmann) (Pl. IV, Fig. 13)
Japanese name : Murasaki-inko

Trichogonia virgata Wiegmann 1837, p. 49.
Septifer crassus Nomura et Hatai 1932, p. 4.
Septifer virgatus Is. Taki 1951, Pl. 18, Fig. 4; Kira 1954, Pl. 45, Fig. 8.

Though the external form of this species is as variable as those of *M. edulis* and *M. crassitesta* which live together with, this surface of shell is sculptured with ribs which are divaricated and the periostracum is purplish in color. Moreover, the interior of shell has an anterior septum for the anterior muscle. By those features, it is easy to separate this species from the mytilid species. The interior is pearly and purplish, not white as in the species *M. keenae*. The crenulations at the margin are extremely variable in this species as well as in its allies so that the subgeneric term *Mytilisepta* was proposed against *Septifer sensu stricto* which has regular minute crenulations at the internal margin.

Locality : Asamushi, Gomejima, Mourajima, Futagojima, Asadokoro, Noheji, Ominato and St. 11.

Distribution : Australia to Japan (north to Yoichi, Hokkaido).

Habitat : This species builds a gregarious mass together with *M. edulis* and *M. crassitesta* at Asamushi on rocks at the intertidal zone.

29. *Septifer* (*Mytilisepta*) *keenae* Nomura (Pl. II, Figs. 9, 10, Pl. IV, Fig. 12)
Japanese name : Hime-igai

Septifer bifurcatus Nomura et Hatai (non Conrad) 1932, p. 3.
Septifer keeni (sic) Nomura 1936, p. 205, Textfigs. 1-5; Is. Taki 1951, Pl. 18, Fig. 5.

This species had been considered to be conspecific with *S. bifurcatus* of California, until Nomura pointed out the distinction of those two species as follows : The shell has sharper or more prominent umbonal ridges with slightly finer radiating ribbets and the interior coloration is pearly white or very slightly purplish. The periostracum is not purplish but brownish.

Locality : Asamushi, Tsuchiya, Gomejima, Futagojima, Noheji and Sts. 12 and 24.

Distribution : Kyushu to southern Hokkaido.

Habitat : This species attaches to rocks composing the association together with *Septifer virgatus*, *Mytilus edulis* and *M. crassitesta*, often among the rhizoids of *Sargassum*, thriving there.

Family PINNIDAE

30. *Atrina* (*Servatrina*) *pectinata* (Linné) (Pl. IV, Fig. 18)
Japanese name : Tairagi

Pinna pectinata Linné 1767, p. 1160.

Pinna japonica Reeve 1858, p. 47.
Pinna lischkeana Clessin 1891, p. 73, Pl. 28, Fig. 1.
Atrina japonica Is. Taki 1951, Pl. 4, Fig. 1 (with *A. j. lischkeana*, Pl. 4, Fig. 2).
Atrina (*Servatrina*) *pectinata* Kira 1954, Pl. 46, Fig. 10.

The shell attains a large size exceeding 20 cm in length and is trigonal in shape, broadly truncated at the posterior margin and tapered to the umbo. The surface is smooth in the typical form, but frequently serrated on the postero-dorsal area as the varietal form *lischkeana*. The intermediate between two forms is found even in the same locality.

Locality: Sts. 5 and 8.

Distribution: The Philippines to Japan. This bay is the northernmost locality.

Habitat: This stands by byssus on the muddy bottom in shallow waters in bays. This is rare in this bay.

Family PECTINIDAE

31. *Chlamys farreri nipponensis* Kuroda (Pl. IV, Figs. 9, 10)

Japanese name: Akazara or Azuma-nishiki

Pecten laetus Gould 1861 (non 1850), p. 91; Nomura et Hatai 1932, p. 3.
Pecten (*Chlamys*) *farreri* Jones et Preston 1904, p. 149.
Pecten laetus ruschenbergeri Takatsuki (non Tryon)1927, p. 22.
Chlamys (*farreri* var.) *nipponensis* Kuroda 1932, app. p. 92.
Chlamys nipponensis akazara Kuroda 1932, app. p. 92, Textfig. 105.
Chlamys nipponensis Is. Taki 1951, Pl. 13, Fig. 4; Kira 1954, Pl. 49, Fig. 11.

This species is easily characterized by many serrated radial ribs on the shell, some of which are stronger than the rest. The coloration is usually purplish brown, but in some specimens it is freshly orange.

P. nipponensis akazara is only a northern form with numerous subequal radial ribs and colored freshly orange. There is no reason to distinguish this form from *Ch. nipponensis* with various kinds of the intermediate forms. Moreover, *Ch. farreri* of China Sea is also connected with this form by the presence of intergrade forms in shape and sculpture. Therefore the scientific name is *Chlamys farreri nipponensis* as a northern form of this species.

Locality: Off Aburakawa, Kugurizaka, Asamushi, Yunoshima, Gomejima, Futagojima, Oshima, Asadokoro, Karibasawa, Noheji, Yokohama and Ominato.

Distribution: China Sea to southern Hokkaido.

Habitat: This scallop is one of the commonest pectinid species in Mutsu Bay, found under the lower tide mark, attaching to the pebbles. This scallop populates the pebbly shore all over the bay and is collected for food instead of *Pecten yessoensis*.

32. *Chlamys* (*Swiftopecten*) *swifti* (Bernardi) (Pl. III, Fig. 4, Pl. V, Figs. 4, 7)
Japanese name : Ezo-ginchaku

Pecten swifti Bernardi 1858, p. 90, Pls. 1,2. Fig. 1; Nomura et Hatai 1932, p. 3.
Chlamys swifti Is. Taki 1951, Pl. 12, Fig. 6 Kira 1954, Pl. 19, Fig. 14.

This species is at sight separable from all other Japanese *Chlamys*-species in having few, broad but low, radial ribs on the surface and the distinctly unequally sized ears, of which the anterior is larger than the posterior. Therefore, Hertlein proposed a section *Swiftopecten* for this species. The coloration is variable but generally white or purple.

Locality : Kanita, Asadokoro and Noheji.

Distribution : Northern Honshu to Alaska.

Habitat : Under the lower tide mark, this species attaches to rocks by the byssus.

33. *Pecten* (*Notovola*) *ablicans* Schroeter (Pl. V, Figs. 1, 2)
Japanese name : Itaya-gai

Pecten albicans Schroeter 1802, p. 135.
Pecten laquetus Sowerby 1842, p. 46, Pl. 15, Fig. 101.
Pecten antonii Philippi 1844, p. 99, Pl. 1, Fig. 1.
Pecten albicans Is. Taki 1951, Pl. 14, Fig. 2; Kira 1954, Pl. 47, Fig. 2.

The right valve of this species is inflated to some extent, while the left is quite flat. There are strong but broad radial ribs on each valve. The ears on both sides of the umbo are almost equal in shape and size to each other. *Pecten sinensis* of Southern Japan has a more strongly inflated right valve and a distinctly excavated left valve.

Locality : Off Tsuchiya and Moura.

Distribution : Kyushu to southern Hokkaido.

Habitat : This species dwells on the fine sandy bottom in shallow waters. The spat is often found attaching to set nets or scallop collectors, but it is rather uncommon in the bay.

34. *Patinopecten yessoensis* (Jay) (Pl. V, Fig. 9)
Japanese name : Hotate-gai

Pecten yessoensis Jay 1856, p. 293, Pl. 3, Figs. 3,4, Pl. 4, Figs. 1,2; Is. Taki 1951, Pl. 14, Fig. 1.
Pecten brandtii Schrenck 1867, p. 411.
Patinopecten yessoensis Kira 1954, Pl. 49, Fig. 16.

This is one of the economically important mussels in Japan and the culture of this species is made in this bay and in Saromako, Hokkaido. This species grows very large in size exceeding 16 cm in length. The valves are more inflated in the

left than in the right, on which radiate about 25 ribs from the umbo. The ears are comparatively small in size and subequal in shape.

This is quite similar to *Patinopecten caurinus* ranging from Alaska to California, but may be distinguished from the latter at a glance in having small ears and a net-work sculpture covering the surface of the left valve and a smaller apical angle.

Locality: Off Kugurizaka, Asamushi, Moura, Futagojima, Oshima, Karibasawa, Noheji, Yokohama, Ominato, Kawauchi, Wakinozawa and Sts. 7, 9, 10, 16, 17 and 23.

Distribution: Northern Honshu to Kuriles.

Habitat: This species lives in the fourth area of this bay, which was named by Yamamoto (1950). This scallop forms a good bed off Kawauchi and Noheji. Its productions in the past fluctuated annualy from about 160 to 30,000 tons.

Family SPONDYLIDAE

35. *Spondylus barbatus* Reeve (Pl. III, Figs. 10, 11)

Japanese name: Umi-giku

Spondylus barbatus Reeve 1856, p. 16; Is. Taki 1951, Pl. 15, Fig. 3; Kira 1954, Pl. 50, Fig. 6.
Spondylus sinensis Sowerby 1847 (non Schreibers), p. 427, Pl. 87, Figs. 32, 33.
Spondylus japonicus Kuroda 1932, app. p. 110.

This species attaches to rocks by the right valve which is deeply concaved. The left valve is rather flattish and arms itself with many spiny projections. The coloration of shell is usually reddish. *S. cruentus* which is the nearest ally, has small and sharply pointed spines on the shell surface.

Locality: Tairadate, Kanita and Kawauchi.

Habitat: Uncommon in the bay. This is found near the shore at the mouth of the bay.

36. *Acesta goliath* Sowerby (Pl. III, Figs. 13, 14, Pl. IV, Fig. 16)

Japanese name: O-hane-gai

Lima goliath Sowerby 1883, p. 30, Pl. 7, Fig. 3; Is. Taki 1951, Pl. 16, Fig. 4.
Acesta goliath Kira 1954, Pl. 52, Fig. 10.

This species attains about 15 cm in height in the fully grown specimen. The shell is white, and its outer surface shows very weak radial stripes which are stronger near the lunule and in the postero-dorsal area than the rest in the young specimen. But in the fully grown the central portion becomes almost smooth. *Acesta smithi* Sowerby is also distributed in Northern Japan, but it has distinct radial ribs all over the surface even in the adult specimen.

Locality: Off Kugurizaka, Asamushi and Noheji.

Distribution : Honshu (down to Sagami Bay) and southern Hokkaido.

Habitat : This is apparently a deep water species, and in fact is the bathymetric records of the collected shells, though not alive, ranging from 30 m to 1417 m.

37. *Promantellum basilanicum hakodatense* (Tokunaga) (Pl. IV, Fig. 7)

Japanese name : Fukure-yukimino

Lima basilanica A. Adams et Reeve 1850, p. 75, Pl. 21, Fig. 6.
Lima hakodatense Tokunaga 1907, p. 64, Pl. 3, Figs. 27a, b.

This white thin shell has numerous radials on its surface, which are somewhat serrated and weakened sidewards. The northern form *hakodatense* is smaller than the southern *basilanicum* (Pl. II Figs. 14, 15) in size and has weaker surface radial ribs. But those two forms have no distinction showing the intergradation between them.

Locality : Off Asamushi and Noheji.

Distribution : The Philippines to southern Hokkaido.

Habitat : This lives under the pebbles in the lower tide mark and can swim freely by the action of valves.

Family ANOMIIDAE

38. *Anomia sinensis* Philippi (Pl. III, Figs. 11, 21)

Japanese mame : Namima-gashiwa

Anomia sinensis Philippi 1849, p. 130.
Anomia cytaeum Gray 1850, p. 115; Takatsuki 1927, p. 21; Kira 1954, Pl. 46, Fig. 8.
Anomia lischkei Dautzenberg et Fischer 1907, p. 210 Pl. 5, Figs. 8-11; Nomura et Hatai 1932, p. 3; Is. Taki 1954, Pl. 17, Fig. 1.

This pearly saddle oyster is a sessile form adhering to the substrate by the calcareous byssus passing through a large perforation in the right valve. The holeless left valve has three scars inside at the center, while the species of the genus *Monia* (Pl. II Fig. 16) which are the nearest allies, have only two scars. The coloration is brown or white . There are no stripped bands as in that genus. The shape is quite variable owing to the sessile life, so that many names have been proposed for this species, besides those cited above.

Locality : Kanita, Ushirogata, Aomori, Kugurizaka, Asamushi, Gomejima, Moura, Mourajima, Futagojima, Oshima, Noheji, Yokohama, Ominato and Kawauchi.

Distribution : Indochina, China to Hokkaido.

Family OSTREIDAE

39. *Ostrea circumpicta* Pilsbry

Japanese name : Kokegoromo

Ostrea circumpicta Pilsbry 1904, p. 559, Pl. 11, Figs. 11, 12.

This was confused with *O. nipponica* Seki by Hirase, but they are easily separable in having minute crenulations on both the anterior and posterior of the hinge in this species and in lacking this feature in that species. In the fully grown stage the right valve is generally somewhat orbicular and solid, covered by a brownish periostracum. It is larviparous as in *O. denselamellosa* and *O. edule*.

Locality : Asamushi, Futago and St. 3.

Distribution : Kyushu to Honshu (north to this bay) and Korea.

Habitat : This attaches to rocks by the left valve under the low tidal level.

40. *Crassostrea gigas* (Thunberg) (Pl. III, Fig. 3, Pl. V, Figs. 5, 8, 10, 11)

Japanese name : Magaki

Ostrea gigas Thunberg 1793, p. 140; Takatsuki 1927, p. 22; Nomura et Hatai 1932, p. 3; Is. Taki 1951, Pl. 8, Fig. 5; Kira 1954, Pl. 51, Fig. 3.

Ostrea laperousi Schrenck 1861, p. 411.

Ostrea tailenwhanensis Crosse 1862, p. 149, Pl. 6, Fig. 6.

This is the most important culture oyster of Japan, the seeds of which are exported to U. S. A. This species is characteristic in having the purplish brown radial zones on the rough surface of the right valve. No crenulation on any of the anterior and posterior sides of the hinge, and the muscle scar is generally tinted deep purple on the chalky white interior. The shape of shell is as variable as that of other oysters.

Locality : Kanita, Okunai, Aomori, Kugurizaka, Asamushi, Gomejima, Moura, Futagojima, Oshima, Noheji, Ominato, Kawauchi and St. 2.

Distribution : China, Japan, Korea and Maritime Prov. of Siberia.

Habitat : This lives in the area of low salinity in bays, attaching to rocks by the left valve in the intertidal zone. The large and solid specimens collected on submarine rocks at Asamushi and other places may be the huge form of this species.

EXPLANATION OF PLATE I

Sketch map of Mutsu Bay with stations where collections were carried out. In addition, collecting the material was made about all along the coast of the bay.

EXPLANATION OF PLATE II

Figs. 1, 2. *Solemya* (*Acharax*) *japonica* Dunker ×2
Figs. 3, 4. *Solemya* (*Petrasma*) *pusilla* Gould ×2
Fig. 5. *Cnesterium johanni* (Dall) ×0.5
Fig. 6. *Acila* (*Truncacila*) *insignis* (Gould) ×2
Fig. 7. *Musculus* (*Modiolarca*) *neglectus* Kuroda ×1
Fig. 8. *Nuculana* (*Thestyleda*) *yokoyamai* Kuroda ×3
Figs. 9, 10. *Septifer* (*Mytilisepta*) *keenae* Nomura ×1.2
Figs. 11, 21. *Anomia sinensis* Philippi Fig. 11, ×0.7; Fig. 21, ×1.2
Fig. 12. *Lithophaga* (*Leiosolenus*) *curta* (Lischke) ×1.2
Fig. 13. *Musculus* (*Musculista*) *senhousia* (Benson) ×1.3
Figs. 14, 15. *Promantellum basilanicum* (A. Adams et Reeve) ×0.6
Fig. 16. *Monia umbonata* (Gould) ×0.5
Figs. 17, 18. *Arca miyatensis* Oyama ×1
Figs. 19, 20. *Striarca* (*Galactella*) *symmetrica* (Reeve) ×3
Figs. 22, 23. *Limopsis tajimae* Sowerby ×1.5
Fig. 24. *Pseudogrammatodon dalli* (Smith) ×1.5
Figs. 25, 26. *Glycymeris yessoensis* (Sowerby) ×1.2

EXPLANATION OF PLATE III

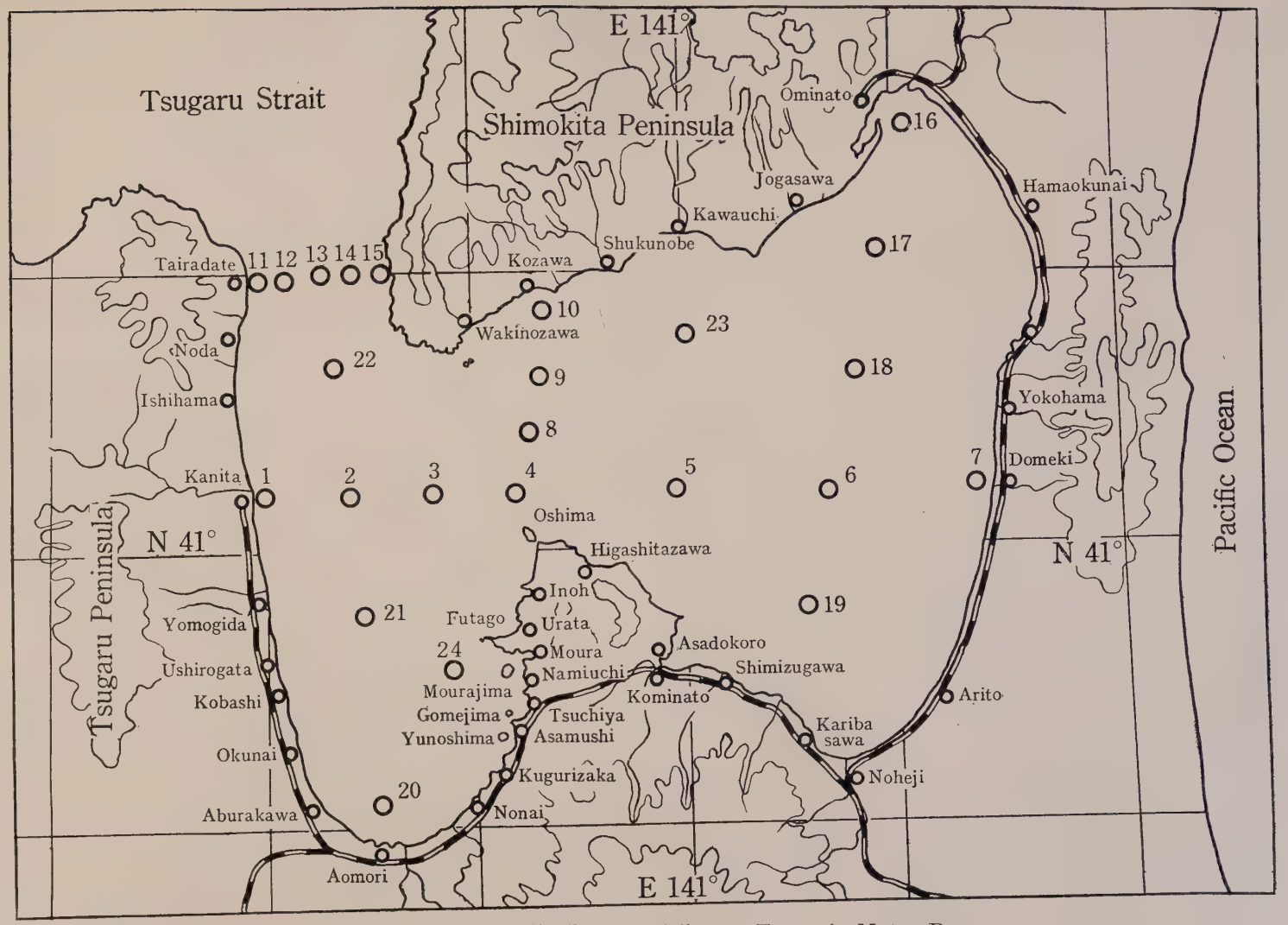
Figs. 1, 2. *Modiolus difficilis* (Kuroda et Habe) ×0.7
Fig. 3. *Crassostrea gigas* (Thunberg) ×0.5
Fig. 4. *Chlamys* (*Swiftopecten*) *swifti* (Bernardi) ×0.7
Figs. 5, 6. *Trichomya hirsuta* (Lamarck)
Figs. 7, 8. *Mytilus edulis* Linné ×0.7
Fig. 9. *Monia umbonata* (Gould) X0.8
Figs. 10, 11. *Spondylus barbatus* Reeve ×1
Fig. 12. *Modiolus* (*Modiolusia*) *elongatus* (Swainson) ×0.5
Figs. 13, 14. *Acesta goliath* (Sowerby) (young specimen) ×1

EXPLANATION OF PLATE IV

Fig. 1. *Cnesterium johanni* (Dall) ×0.6
Fig. 2. *Arca arabica* Philippi ×1.3
Fig. 3. *Anadara* (*Scapharca*) *troscheli* (Dunker) ×0.8
Fig. 4. *Anadara* (*Scapharca*) *subscrenata* (Lischke) ×0.6
Fig. 5. *Cnesterium notabile* (Yokoyama) ×0.8
Fig. 6. *Arca boucardi* Jousseaume ×0.6
Fig. 7. *Promantellum basilanicum hakodatense* (Tokunaga) ×0.6
Fig. 8. *Glycymeris yessoensis* (Sowerby) ×0.8
Figs. 9, 10. *Chlamys farreri nipponensis* Kuroda ×0.5
Fig. 11. *Modiolus nipponicus* (Oyama) ×0.8
Fig. 12. *Septifer* (*Mytilisepta*) *keenae* Nomura ×1
Fig. 13. *Septifer* (*Mytilisepta*) *virgatus* (Wiegmann) ×0.7
Fig. 14. *Mytilus* (*Crenomytilus*) *grayanus* Dunker ×0.5
Fig. 15. *Mytilus crassitesta* Lischke ×0.7
Fig. 16. *Acesta goliath* (Sowerby) ×0.7
Fig. 17. *Trichomya hirsuta* (Lamarck) ×1
Fig. 18. *Atrina* (*Servatrina*) *pectinata* (Linné) ×0.3
Fig. 19. *Mytilus* (*Crenomytilus*) *grayanus* Dunker ×0.8
Fig. 20. *Modiolus* (*Modiolusis*) *elongatus* (Swainson) ×0.4

EXPLANATION OF PLATE V

Figs. 1, 2. *Pecten* (*Notovola*) *albicans* (Schroeter) ×0.7
Fig. 3. *Anadara* (*Scapharca*) *broughtonii* (Schrenck) ×0.3
Figs. 4, 7. *Chlamys* (*Swiftopecten*) *swifti* (Bernardi) ×0.5
Figs. 5, 8. *Crassostrea gigas* (Thunberg) ×0.5
Fig. 6. *Lithophaga* (*Leiosolenus*) *curta* (Lischke) ×1.2
Fig. 9. *Patinopecten yessoensis* (Jay) ×0.5
Figs. 10, 11. *Crassostrea gigas* (Thunberg) ×0.5



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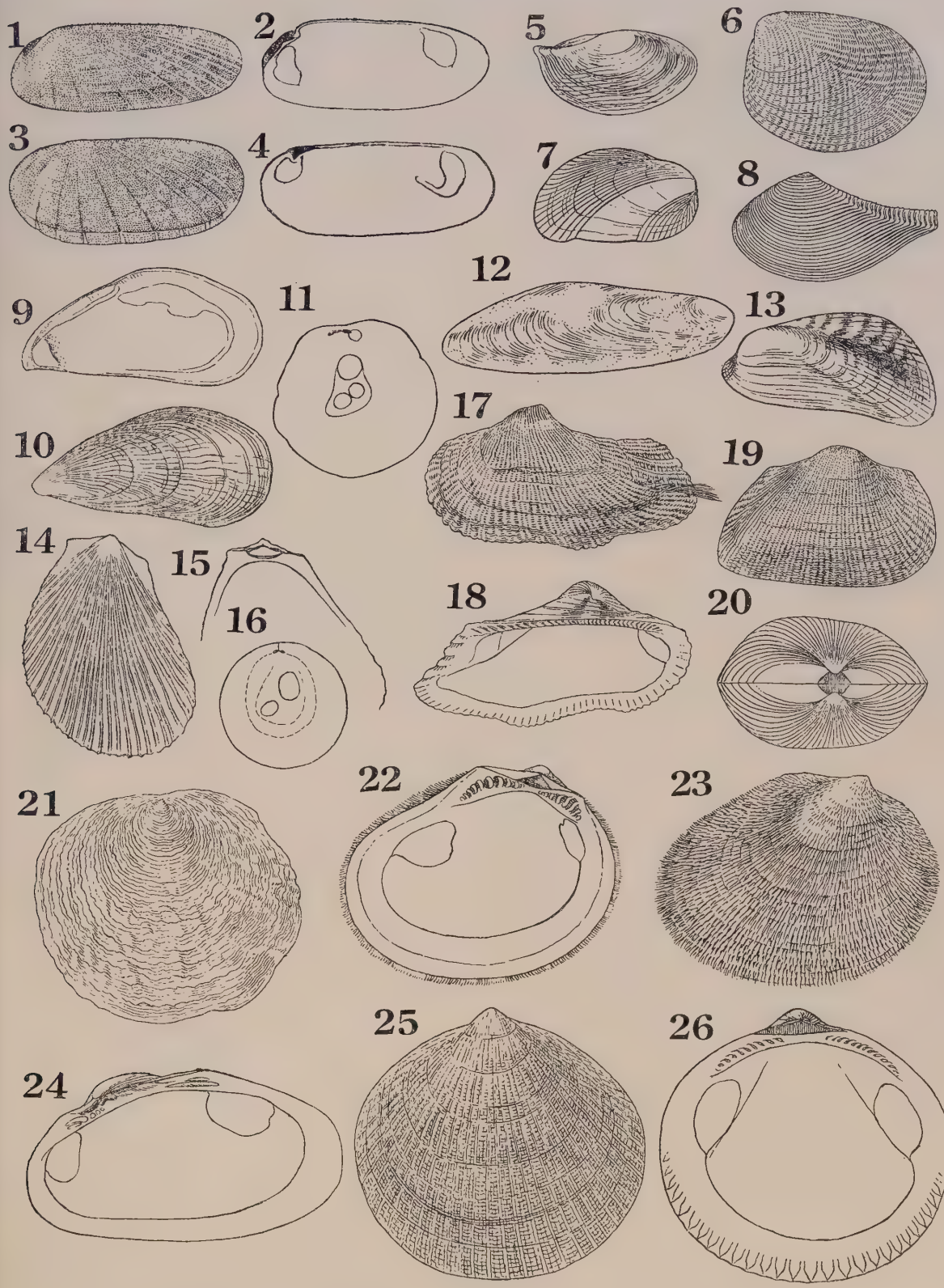

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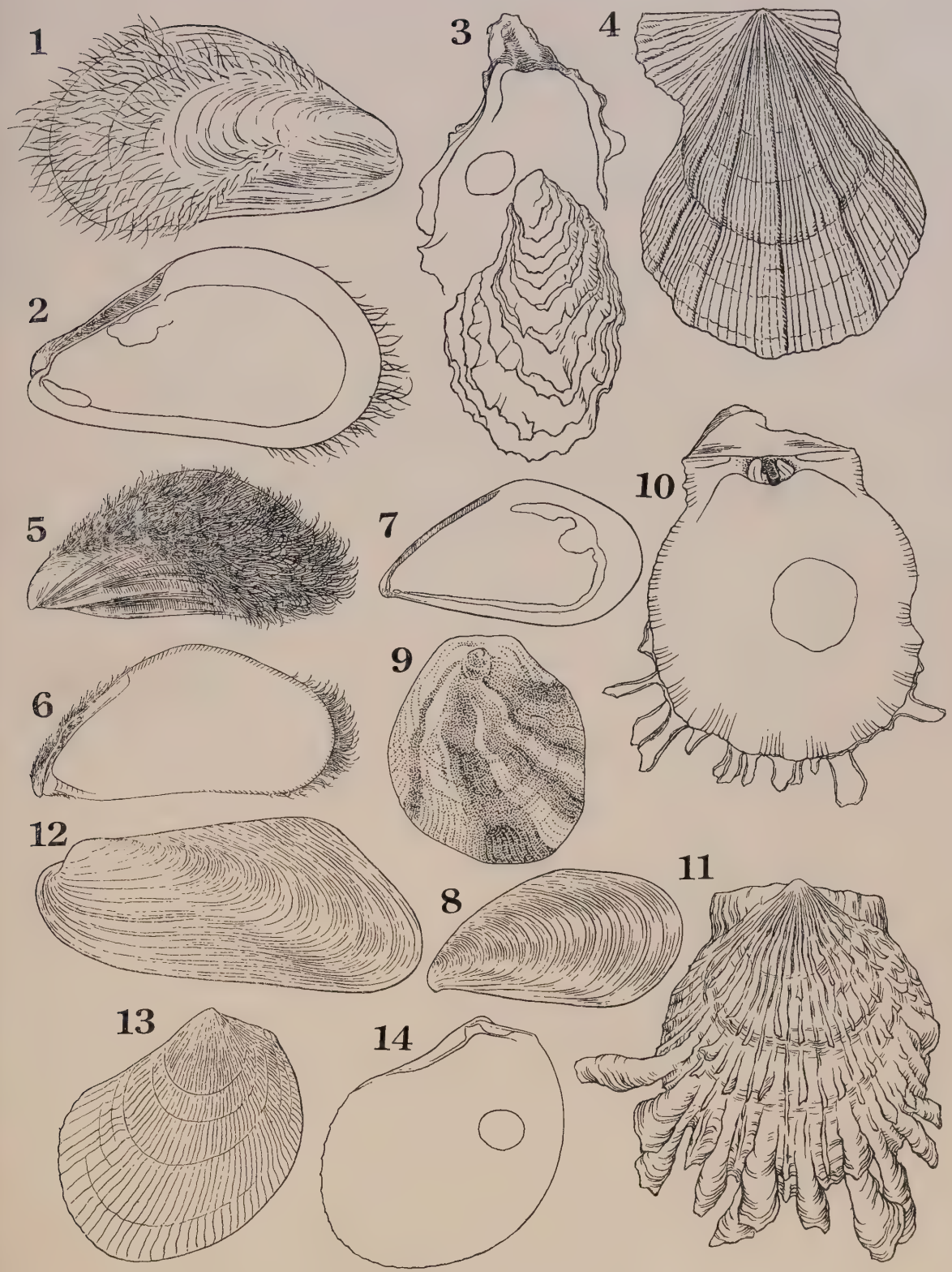

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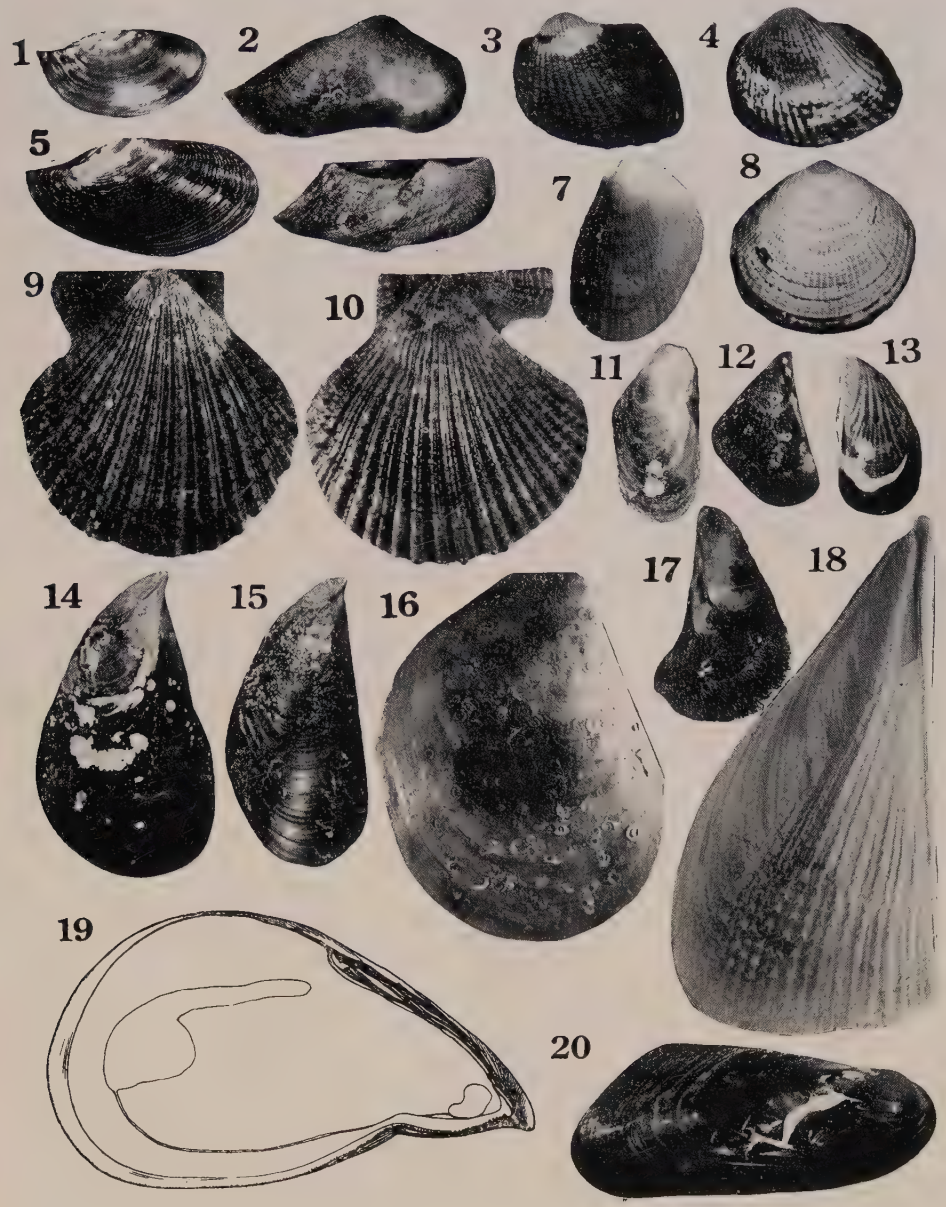

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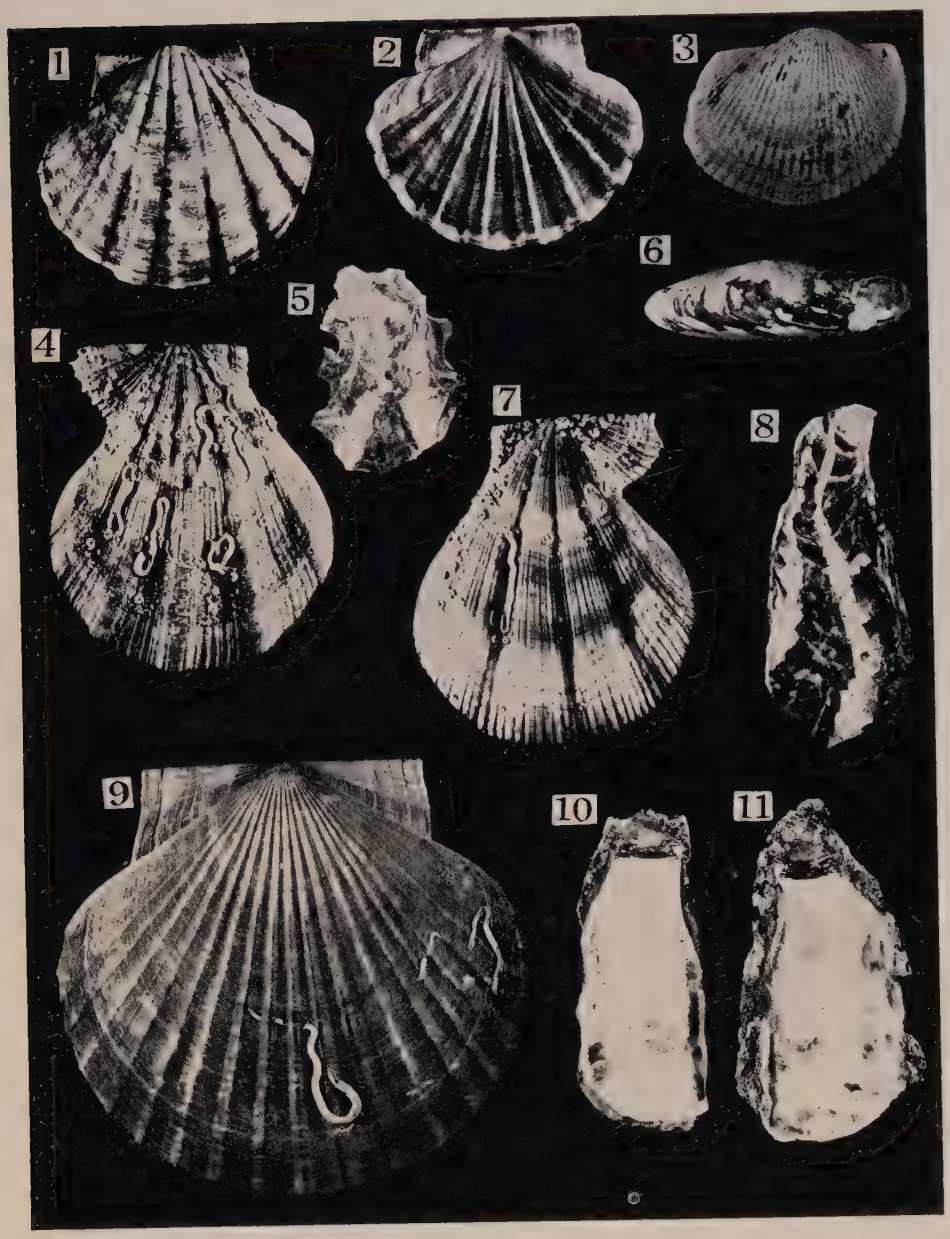
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BULLETIN OF THE MARINE BIOLOGICAL STATION OF ASAMUSHI,
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MORPHOLOGICAL OBSERVATIONS OF ASCIDIAN LARVAE
4. *STYELA PLICATA* (LESUEUR)[1,2]

By

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(With one figure)

Styela plicata (Lesueur), Japanese species name Shiroboya, is a solitary ascidian common in the neighborhood of the Marine Biological Station of the Tokyo University at Misaki, Kanagawa Prefecture, Japan. On June 21, 1957, the 33 specimens which were collected near the Misaki Marine Bilogical Station were placed in a jar cooled with ice for transportation to the aquarium of the Marine Biological Station of the Tôhoku University at Asamushi. A day after becoming adapted to the aquarium, some of the materials liberated many eggs, and the swimming larvae could be obtained about 12 hours after the liberation at 19–20°C. Therefore it is supposed that the breeding season of this species is in early summer.

Before going further, the writer thanks Dr. I. Tomiyama, Director and other members of the Misaki Marine Biological Station for their kind assistance in collecting the materials.

(1) DIAGNOSTIC CHARACTERS OF THE LARVAE

Form and size : External form is of slender type. Body is spindle shaped and the anterior wall of the ectodermal epidermis is thick and pointed. Total length, ca. 1.3 mm, body length ca. 0.24 mm, and body depth ca. 0.12 mm. Stouter bodies are found in some individuals.

Structure of the larval organs : There are three adhesive papillae in triangular arrangement. In some larvae, the adhesive papillae are difficult to observe as they differentiated not so distinctly. There is a typical static organ in the sensory vesicle. The eye was observed as a small black pigmented spot in the dorsal wall of the vesicle in the living tadpole. The cellular structure of the notochord is not always distinct, but nearly tubular in some larvae. The notochord is transparent

1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 235.

2) Aided by a grant from the Scientific Research Expenditure of the Department of Education.

and contains some orange granules. The muscle bands at both sides of the notochord contain dark orange granules.

Rudiments of the adult organs : The rudiments of the adult organs are poorly developed. The rudiments of the endodermal organs which are situated almost horizontally in the body, are semi-transparent and light purple gray in color without distinct granular structure.

Relative position of sensory vesicle, branchial and atrial apertures : Branchial and atrial apertures are not yet visible in the larvae, but their relative positions are of the type linear parallel to the body axis on the dorsal side of the body.

(2) REMARKS

The tadpole larva of this species is of the Type I or *Cynthia* type, Subtype I or Simple type (Hirai 1951). The tadpole larva of this species has a characteristic reduced type of the eye as is observed in the other *Styela* species (Berrill 1950). In *Styela partita* (Conklin 1905), the muscle cell of the tail contains

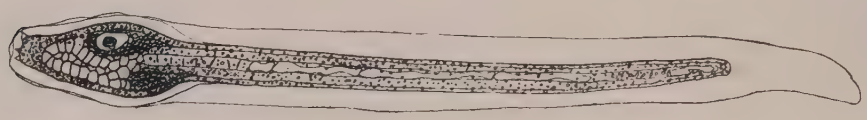

Fig. 1. Left side view of living tadpole larva of *Styela plicata*. ×93.

the deep yellow protoplasm, the notochord contains light gray material and the endoderm slate gray substance of the egg respectively, while, in *Styela plicata*, the endodermal organs contain light gray cytoplasm, whereas the notochord and the muscle of the tail contain orange cytoplasm respectively.

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BULLETIN OF THE MARINE BIOLOGICAL STATION OF ASAMUSHI,
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ON THE SPECIES OF *CLADONEMA RADIATUM* VAR. *MAYERI* PERKINS[1)]

By

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Medusae belonging to the genus *Cladonema*, which are very common in Japan, were reported as *Cladonema radiatum* var. *mayeri* Perkins by Uchida (1925 and '27 a, b) based on the structure of the medusa. In 1957, Hirai and Kakinuma succeeded to rear this variety in the laboratory of the Marine Biological Station at Asamushi, and reported on its developmental cycle and the structure of the hydroid. They discussed that the structure of the hydroid of this variety found at Asamushi is different from that of *C. radiatum* Dujardin and *C. mayeri* Perkins. In 1949, Rees compared his *C. myersi* Rees with *C. radiatum* var. *mayeri*, and stated "Unfortunatelly the full life history of the Japanese species remains unknown and I have no specimens to compare with the present species". From the newly found features in the developmental cycle of this variety, the present writer is inclined to consider that it represents a new species, for which he wishes to propose the new species name *Cladonema uchidai* n. sp.

Before going further, I thank Prof. Dr. Tohru Uchida for his valuable taxonomic suggestions given me during the course of my investigation.

DESCRIPTION

Uchida (1927a) described that the Japanese *Cladonema* medusa, *Cladonema radiatum* var. *mayeri* Perkins, is very common in Japan and agrees with the description and figures of *C. mayeri* as to the structure of the medusa. The *Cladonema* medusa which was found at Asamushi was also described as the same species (Uchida 1927b). In 1957, Hirai and Kakinuma investigated the developmental cycle of the species at Asamushi based on 30 colonies which were reared by them and on three which were found in the sea and in the aquarium. In this investigation, they found that the hydranth of the form has typically four capitate tentacles but no filiform tentacles. When the structure of the hydranth was compared with that of *C. radiatum* and *C. mayeri*, it became clear that the latter

1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 236.

two species each has four filiform tentacles showing distinct difference from the former which has no filiform tentacles. Therefore, it is clear that the Japanese species is distinct from *C. radiatum* and *C. mayeri*. On the other hand, the structures of the hydroid and medusa resemble those of *C. myersi* Rees (Rees 1949). The hydroid of *C. myersi* Rees has four oral capitate tentacles but is completly devoid of filiform tentacles as was observed in the Japanese species. Rees described that the hydroid has a simple, creeping stolon which is lightly branched, but the hydroid of the Japanese species has distinctly branched stolon as already described (Hirai and Kakinuma 1957a). The chief differences between *C. myersi* and the Japanese species are in the structure of the medusa, and their differences are shown in the following Table.

	C. myersi	*C. radiatum* var. *mayeri*
Hydroid, filiform tentacle	—	—
Medusa, radial canals	5-7	8, 9
oral tentacles	6	6
tentacular appendages (at liberation)	2	1
tentacular appendages (adult)	3	3
ocellus	reddish	deep purple, nearly black
tentacle	much branched	much branched

C. myersi has seven, rarely five or six, unbranched radial canals, but the Japanese species has typically nine at the bell margin, and six of them at the origin, the alternate ones branching dichotomously (Uchida 1925 and '27a, b, Hirai and Kakinuma 1947a). This structure is visible also in the young medusa just liberated from the hydranth (Hirai and Kakinuma 1957a). In the Japanese species, rarely five to eight abnormal canals were observed in the reared materials, but the branching character of the radial canal hardly disappear except in very rare cases which had five or six canals. In the medusae collected in the sea, it was difficult to observe such abnormal radial canals as in the reared materials, but rarely the medusae which had eight canals were observed. Tentacular appendages of medusa at liberation of the Japanese species is always only one in each tentacle (Uchida 1927a, Hirai and Kakinuma 1957a), but *C. myersi* has two adaxial appendages. The tentacular appendage of the Japanese species terminates in a well developed knob of nematocyst, but that of *C. myersi* has a few nematocysts at the somewhat swollen tip. The ocellus of *C. myersi* is reddish, while that of the Japanese species is deep purple or nearly black in color.

As mentioned above the Japanese medusa resembles *C. myersi*, but is distinguishable from the latter in the structures of the medusa. As already described,

the Japanese species is also distinct from *C. radiatum* and *C. mayeri* in the structure of the hydroid. Therefore, the Japanese species is here considered to represent a new species rather than a variety of *C. radiatum*, for which the present writer proposes here the new species name *C. uchidai* n. sp.

CLADONEMA UCHIDAI N. SP.

The species formerly described by Uchida (1925 and '27a, b) as *Cladonema radiatum* var. *mayeri* Perkins differs from *C. radiatum* Dujardin and *C. mayeri* Perkins mainly in the structure of the hydroid, and also from *C. myersi* Rees in the structure of the medusa.

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SYNECOLOGICAL STUDY ON INTERTIDAL COMMUNITIES

I. THE ZONATION OF INTERTIDAL ANIMAL COMMUNITY WITH SPECIAL REFERENCE TO THE INTERSPECIFIC RELATION[1)]

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(With one figure)

As the zonation of marine invertebrates within narrow vertical limits of the sea cliff is a striking feature, ecological investigations have been done by many authors. Some investigators have examined the relation between the animal zones and the environmental factors governing a certain locality, and the other workers tried to analyse the ecological succession in the intertidal region. It is interesting to notice that Stephenson and Stephenson (1949) suggested that the fundamental intertidal zonation is found universally.

Studies concerned with the environmental factors were carried out by the thought that the distribution of the intertidal animals may be limited by critical environmental factors. Though the intertidal community is classified into zones by various characteristic species, it is easily supposed that these species are not only arranged by the environmental conditions, but are also influenced by the biotic factors, so called "coaction". It is generally said that competition for space exists among them, and also that a change of the constituent species is often recognized. The ecological succession in the intertidal region had been noted by Hewatt (1935, 1937), Kanda (1947), Katada and Matsui (1953) and Newcombe (1935).

Nevertheless, the mechanism of the replacement in the constituent species is not yet sufficiently clarified. Therefore, the writer attempted to study the interrelation among the organinsms which appear in the forming process of zonation, and in the present paper an analysis of the zonation on the cliff face of a headland will be dealt with.

Acknowledgement is due to Prof. M. Katô, Tôhoku University for his valuable

1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 237.

guidance and criticism and Dr. H. Utinomi, Kyoto University for his identification of barnacles.

SAMPLING METHOD

The headland, Tobi-ga-Saki, is situated near Matsushima Bay, Pacific coast of Miyagi Prefecture, northern part of Japan. The headland is composed of tuff and extends seawards from the sandy shore. The surface of the steep cliff is relatively smooth and faces south except for Sts. 1, 3 and 4.

Seven stations were selected for sampling from the beach towards the sea. For quantitative investigation, a belt (50 cm in width) was selected vertically on the cliff face in each station, and this was divided into horizontal belts at intervals of 10 cm above and below high water level. The horizontal belt (10×50 cm) is subdivided into five 10 cm squares. The individual number of the animals in each square were counted. In the case of two species of porifera, the percentage of the area covered by them was estimated.

The examination was carried out from May to June 1956. The seasonal change in the population of these animals was not so remarkable, thus the zonation was rather stable during this period. Only animals, especially sedentary animals were examined, because in the area studied no algal zone was found. In the vicinity of Matsushima Bay the characteristic sedentary animals which form the zones are: *Chthamalus challengeri* Hoek, *Balanus amphitrite albicostatus* Pilsbry, *Ostrea gigas* Thunberg, *Septifer virgatus* (Wiegmann), *Mytilus edulis* Linné, *Reniera japonica* Kadota and Sponge sp. 1.

As the distribution of the animals seems to correlate generally to the wave action, the intensity of it was studied. When the wave washes the cliff, three kinds of surf are recognized, viz. splash, breaker and brushing water. The degree of desiccation of the rock face during the tides in summer was also observed in relation with the distribution of the animals. Washing limits of each kind of surf during the high tide and also the drought part and wet one during the tides on a calm day, were noticed.

PHYSIOGNOMICAL DESCRIPTION

Station 1. The wave action is relatively weak, for the cliff faces west and is sheltered from the surging wave. The cliff is divided into two parts of splashing water and brushing water. The rock face dries up between the tides in summer. Zones of *C. challengeri*, *C. challengeri–O. gigas*, *B. a. albicostatus–O. gigas–M. edulis* and *M. edulis–B. a. albicostatus* arranged in the order from the upper part downwards were recognized.

Station 2. This station faces south and wave action is stronger than in St. 1. Here the feature of zonation is similar to that in St. 1, except for that *M.*

edulis increases in number and in the patches of it *S. virgatus* appears.

Station 3. The strong wave washes the cliff which faces southeast. The cliff consists of the splashing water part and the breaker one. The rock face dries up between the tides in summer. From the upper part to the lower part, zones of *C. challengeri*, *C. challengeri–O. gigas*, *M. edulis–S. virgatus* and *B. a. albicostatus–O. gigas* are constructed. In the breaker part *M. edulis* and *S. virgatus* crowd remarkably.

Station 4. The environmental condition and zonation in this station are similar to that in St. 1. But *R. japonica* appears in the wet part.

Station 5. Here, the cliff faces south and the wave action is stronger than in St. 2, and splash raises upwards. The highest zone is dominated by *C. challengeri* and the next consists of *C. challengeri*, *B. a. albicostatus*, *O. gigas*, *S. virgatus* and *M. edulis*. Dominant species in the third zone are *O. gigas* and *R. japonica*. In the fourth zone *M. edulis* and *S. virgatus* dominate contrary to the decreasing of *O. gigas*. The fifth is the *M. edulis* zone and the lowermost one is the *O. gigas* zone.

Station 6. Waves wash the rock stronger than in the above-mentioned stations. In response to the strong splash the *C. challengeri* zone extends to the upper part. Under it the *M. edulis–S. virgatus* zone develops. The *M. edulis–R. japonica* zone follows it. The fourth zone consists of *M. edulis*. The lowest is the *O. gigas* zone.

Here, *B. a. albicostatus* disappears and *O. gigas* decreases in the upper part. In the wet part *R. japonica* and Sponge sp. 1 appear abundantly.

Station 7. The wave action is stronger than in St. 6. In spite of the raising of the upper limit of the distribution of *C. challengeri* which is accompanied with raising of the splash, the *C. challengeri* zone does not extend, for its lower limit raises. Under it *M. edulis* and *S. virgatus* form a remarkable zone. The Sponge sp. 1–*M. edulis* zone lies between the *M. edulis* zone and the *M. edulis–S. virgatus* zone. The lowest is the *O. gigas*–Sponge sp. 1 zone.

In this station *O. gigas* disappears from the upper part and *R. japonica* vanishes from the middle part.

NUMERICAL TREATMENT

In Fig. 1, the results of quantitative studies on the animals in each horizontal belt in Sts. 1, 3, 5 and 7 are represented by the black bars. As shown in Fig. 1, the obtained results correspond with the above-mentioned physiognomical descriptions.

The noteworthy features recognized are the following:

1. Accompanied with the raising of the upper limit of the splash area the range of the distribution of *C. challengeri* extends upwards, but this zone can be

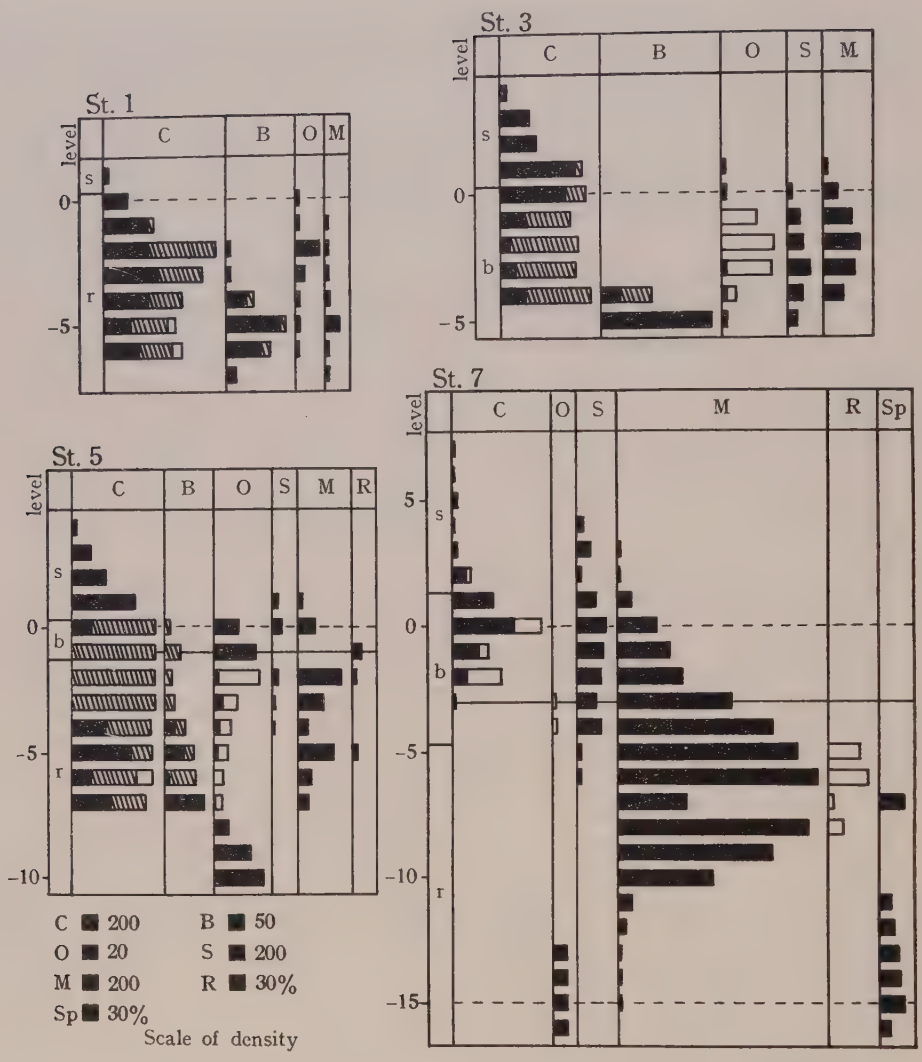

Fig. 1. The vertical distribution of the animals is illustrated with the individual number in a horizontal belt and with the percentage of the covered area to the total area of a belt in the case of two species of porifera. The present number is represented by the black bars, the number covered with *O. gigas* by the shaded bars and that covered with *M. edulis* by the white bars.

The abbreviations used in the figure are the following:

C. - *C. challengeri*, B. - *B. a. albicostatus*, O. - *O. gigas*, S. - *S. virgatus*, M. - *M. edulis*, R. - *R. japonica*, Sp. - Sponge sp. 1.

s. --- splash part, b. --- breaker part, r. --- brushing water part. Unbroken line --- the border line between the wet part and the drought. Broken line in 0 level --- high water level. Broken line in -15 level --- low water level.

divided into the upper and lower strata in St. 5. The lower part of the *C. challengeri* zone becomes narrow in Sts. 3 and 7 where *M. edulis* and *S. virgatus* settle.

2. *B. a. albicostatus* disappears in St. 7.

3. *R. japonica* is not found in St. 7.

4. *O. gigas* distributes continuously in St. 1 but separates into two strata in Sts 3 and 5. Between these strata *M. edulis* dominates and in St. 7 *O. gigas* is found only in the lower part between tide marks.

Furthermore, with respect to each horizontal zone, the percentage of individual number of *M. edulis* in each of the five squares to the total number of the same species in each zone was statistically compared with that of the other species. The following results were obtained from this treatment. Namely, *C. challengeri* decreases in number where *M. edulis* and *S. virgatus* settle abundantly, because the rock face for settlement of *C. challengeri* becomes narrow. It is noted that at the lower part of the *C. challengeri* zone many small spats of *C. challengeri* settle on the shell of mussels resulting in the increasing of individual number.

In the case of *B. a. albicostatus*, the same tendency as in *C. challengeri* is suggested but fewer individuals attach to the shell of bivalves.

In St. 1, *M. edulis* accumulates around the shells of *O. gigas* and by the increase in its individual number *O. gigas* is compelled to form a narrow survival zone there. As usual, *S. virgatus* appears within the clusters of *M. edulis*.

The inversely proportional relation tends to be found between *C. challengeri* and *O. gigas*, for the individual number of *C. challengeri* which attached to the shell of *O. gigas* is less than on the bare rock. At "–7" of St. 1, *B. a. albicostatus* attaches to the rock face where *C. challengeri* does not settle, and the relation between both species is inversely proportional.

It was readily recognized that the inverse relation between *M. edulis* and *O. gigas* was due to that the latter was covered with the former. Therefore, to examine this fact *M. edulis* was removed from the substrata by cutting off the byssus threads. Beneath it there were found shells of *C. challengeri* and *O. gigas* and *R. japonica*. Among these shells blanketed by *M. edulis* all individuals of *C. challengeri* were dead, the majority of *O. gigas* were also dead, though a few of them were still lived, almost all of the dead animals had the two valves intact completely suggesting that *O. gigas* was killed by the blanketing of *M. edulis*.

R. japonica which was found covered with *M. edulis* was living.

Moreover, *C. challengeri* and *B. a. albicostatus* are covered with *O. gigas*. It is supposed that the two species of barnacles were killed by the covering with *O. gigas* judging from that each of them still possessed both tergum and scutum.

The distribution of the animals covered with *M. edulis* is represented by the white bars, and that covered with *O. gigas* by the shaded bars in Fig. 1.

From the above, it is clear that the distribution and the abundance of the barna-

cles are influenced by *O. gigas* and *M. edulis*. The individual number of barnacles is reduced by the covering of *O. gigas* and *M. edulis*. The present number of *C. challengeri* reaches to half of the initially settled animals in St. 1. In St. 3, the reduction of its population is most remarkable. In St. 5, the initial and continuous *C. challengeri* zone is divided into two strata by the effect of the covering of *O. gigas* in its middle part. *O. gigas* spreads over the bare rock and the shells of barnacles, and then brings about the settling of *M. edulis* and consequently is covered with the latter. The *O. gigas* zone is covered with so many individuals of *M. edulis* in its middle part that *O. gigas* distributes in two separated strata in Sts. 3 and 5. In the upper part of St. 7 the settled *O. gigas* was completely covered with *M. edulis*. From the appearance of *R. japonica* after the removal of *M. edulis* it is evident that a remarkable *R. japonica* zone had been formed in the middle part of St. 7. The covering was not found between two species of barnacles, except for only two cases where two individuals of *B. a. albicostatus* covered some of *C. challengeri*.

DISCUSSION

From the results that the covering phenomena in the course of the formation of zonation are recognized as is mentioned above, it is known that the zonation was not always formed in response of each constituent species to the environmental factors. McDougall (1943) described that three forming processes of zonation are recognized and that larvae settle uniformly but adverse conditions destroy them above and below certain limits. From the results of the present study it seems that the effect of the other species is also one of the adverse conditions. It has been described that the raising of the upper limit of the Balanoid zone and the lowering if the lower limit of it are due to the increase in the intensity of the surf (Moor 1935, Evans 1947). In the present study, in spite of the increase in the intensity of wave action, the lower limit of *C. challengeri* does not become lower in St. 7, and *C. challengeri* distributes in two separated strata in St. 5. The same phenomenon as observed in *C. challengeri* was found also in *O. gigas* in Sts. 3 and 5.

According to Katada and Matsui (1953) the lower limit of one species varies by the effect of the other species which appear successively. However, such phenomenon is observed not only in the lower limit, but also in other parts there appears generally a modification of the zone constituents by the interspecific relation. The lower parts of the *C. challengeri* zone in each station are covered with *O. gigas*, whereas the middle part of the *O. gigas* zone in Sts. 3 and 5, and the upper limit of it in St. 7 were covered with *M. edulis*.

In St. 7 *R. japonica* was completely covered with *M. edulis*.

Stephenson (1939) illustrated the colonization by patches of brown algae in the Balanoid zone. It is noticed by Evans (1949) that modification of the Balanoid

zone occurs by the invasion of Fucoid algae, *M. edulis* and others. Hewatt (1935) observed that the denuded rock face was dominated by *Mytilus californianus* after the successive change of settled animals. In the present research it may be said that it is usual that at the first stage *C. challengeri* and *B. a. albicostatus* which settle on the rock are covered first with *O. gigas* and subsequently *O. gigas* is covered with *M. edulis*. But occasionally *C. challengeri* is directly covered with *M. edulis*. It seems that *R. japonica* is directly coverd with *M. edulis*.

SUMMARY

Zonations on the cliff of a headland were studied with special reference to the interrelation of animals.

In the splash water part, there appear *C. challengeri* and *O. gigas*. In the breaker part and brushing water part, the zones consist of *C. challengeri*, *B. a. albicostatus*, *O. gigas*, *S. virgatus*, *M. edulis*, *R. japonica* and Sponge sp. 1.

The distribution of *C. challengeri* and *B. a. albicostatus* is modified by the invasion of *O. gigas*.

It was clarified that the distribution of *C. challengeri*, *B. a. albicostatus*, *O. gigas* and *R. japonica* was modified by the covering of *M. edulis*.

From the obtained results, it is concluded that the covering by other species is one of the important factors in the course of the determination of zonation.

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ON THE BREEDING OF A PERIWINKLE, *LITTORIVAGA ATKANA* (DALL)[1,2,3]

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(With one figure and one plate)

Littorivaga atkana (Dall) is a common periwinkle on the rocky coast in the neighborhood of the headland of Tachimachi in Hakodate, Hokkaidô, Japan. The writer observed the breeding of *Littorivaga atkana* (Dall) in February, 1957, at the headland of Tachimachi and found that it liberates and deposits eggs on the stones.

Here the writer thanks Dr. Eturô Hirai, Director of the Marine Biological Station of the Tôhoku University at Asamushi, Aomori Prefecture, Japan, for his supervision during the course of this investigation, and Mr. Seiji Ishikawa, of the Hakodate Municipal Museum, and Mr. Tatsuo Yusa, of the Hokkaidô Regional Fisheries Research Laboratory, for their kind aids given to the writer in collections.

MATERIAL AND METHOD

From December, 1956, to May, 1957, specimens of *Littorivaga atkana* (Dall) were collected from high to low tide of the rocky coast in the neighborhood of the headland of Tachimachi in Hakodate. The materials were cleaned carefuly with fresh water and 10～15 animals were placed in each separate glass bottle, each containing about 30 cc sea water. During the breeding season after the bottles containing the animals were filled with sea water, the liberated eggs were found on their bottoms. The liberated egg masses were also observed in the field at the headland of Tachimachi.

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1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 238.

2) The Japanese name is Kurotamakibigai.

3) Acknowledgements are due to Dr. Tadashige Habe, of the Amakusa Marine Biological Laboratory of the Kyushu University at Amakusa, Kumamoto Prefecture, Japan, for his kind identification of this species. On February 5th, Dr. Habe informed to the writer that *Littorivaga atkana* (Dall) must be included in the genus *Neritrema* Recluz, 1869, mainly based on its mode of reproduction mentioned in the present paper.

OBSERVATION

The specimens of *Littorivaga atkana* (Dall) which were collected from rocky coast of the headland of Tachimachi (Fig. 2), from high to low tide on January 25, 1957, were received by the writer on January 26th. The animals were placed in a bottle, and on January 27th four separated eggs with faeces were found on the bottom of the bottle. The liberated egg capsule was covered by a thin membrane and surrounded by an oval, colorless and transparent capsule which was about 550 μ in diameter, and about 400 μ in thickness (Fig. 1). The egg was about 200 μ in diameter, and only one egg was found in each capsule. On February 3rd and 5th the animals which were placed in a bottle, liberated many eggs among which six eggs gathered in a mass (Fig. 6) in the laboratory. On February 3rd, the writer found the same deposited eggs in the ootheca of this species on the sides of stones at a place about 25 cm higher than the datum sea water level of the coast of Tachimachi (Fig. 5). The side of an ootheca is about 37×25 mm and includes about 120 egg capsules, and several oothecas gather to form larger masses. On March 31st, the largest masses were found on the coast of Sumiyoshi-cho in the neighborhood of the headland. The size of the masses is about 380×120×40 mm, and many animals were observed gathering near the egg masses (Fig. 3). Then on May 25th, the animals were observed which migrated to the high water level or a higher level from near low water tide. The liberated eggs required about four weeks to hatch from the capsules, and the young larvae did not swim in the bottles, but creeped on the bottom surfaces. The breeding continued from January to March on the rocky coast of Tachimachi.

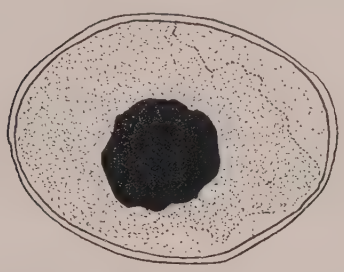

Fig. 1. The egg and capsule of *Littorivaga atkana* (Dall). ×78.

CONSIDERATION

Littorivaga atkana (Dall) liberates the deposited egg masses on the rocks. The egg mass consists of many capsules in ootheca, and its egg capsule is oval. According to Lebour (1937) *Littorina* (*Littorivaga*) *saxatilis* (Olivi) (=*L. rudis*) is viviparous, Thorson (1946) states that *Littorina saxatilis* (Olivi) var. *tenebrosa* Maton is viviparous, while Seshappa (1947) observed that *Littorina saxatilis* (Olivi) liberates egg masses. *Littorivaga brevicula* (Philippi) is oviparous and liberates helmet-shaped planktonic eggs (Kojima 1957). The common liberation type of the deposited egg masses is found in *Littorina* (*Neritoides*) *littoralis* (L.) (=*L. obtusata*) (Lebour 1937), *Littorina obtusata* Linné (Thorson 1946), while the latter species liberates the egg masses on the sea weed, and the egg capsule is elongate-

oval or of kidney shape. The migration of *Littorivaga atkana* (Dall) after the breeding season will suggest its seasonal migration.

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Plate VI. Breeding of *Littorivaga atkana* (Dall).

Fig. 2. The headland of Tachimachi in Hakodate, Hokkaidô, Japan.
Fig. 3. Largest egg masses of *Littorivaga atakna* (Dall) on a stone at Sumiyoshihama, Hakodate.
Fig. 4. The adult specimens of *Littorivaga atkana* (Dall).
Fig. 5. The egg masses of *Littorivaga atkana* (Dall) collected from the field.
Fig. 6. The liberated egg mass of *Littorivaga atkana* (Dall) in the laboratory.

Fig. 2.

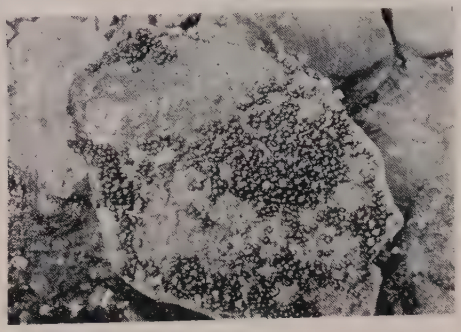

Fig. 3.

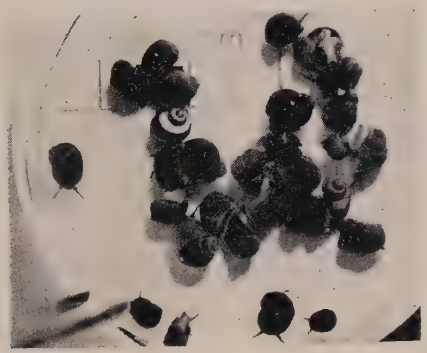

Fig. 4.

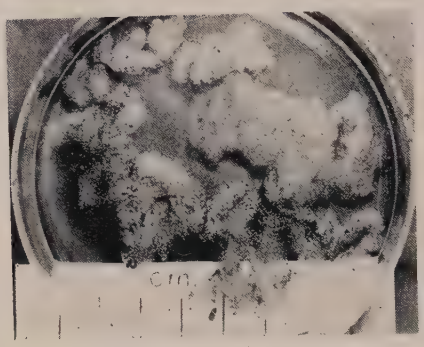

Fig. 5.

Fig. 6.

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A NEW TYPE OF THE EGG CAPSULE OF A PERIWINKLE, *LITTORINA SQUALIDA* BRODERIP ET SOWERBY[1,2,3]

By

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(With one figure)

Hirase (1927) and Kuroda (1955) described that *Littorina* (*Algaroda*) *squalida* Broderip et Sowerby is oviparous, but the details of its breeding had not been confirmed (Habe 1956). On July 10, 1957, mature specimens of *Littorina squalida* Broderip et Sowerby were received from the Akkeshi Marine Biological Station of the Hokkaidô University at Akkeshi, Hokkaidô, Japan, for examination. The writer investigated the spawned eggs of this species in the laboratory at the Marine Biological Station of the Tôhoku University at Asamushi, Aomori Prefecture, Japan, and the results are reported in this article.

Here the writer thanks Dr. Eturô Hirai, Director of the Marine Biological Station of the Tôhoku University at Asamushi, for his supervision during the course of this investigation, and to Mr. Fumio Iwata, of the Akkeshi Marine Biological Station of the Hokkaidô University at Akkeshi, for his kind offer of the specimens.

MATERIAL AND METHOD

In 1957, four mature specimens of *Littorina squalida* Broderip et Sowerby which were collected from high water tide in the neighborhood of the Akkeshi Merine Biological Station at Akkeshi, were received by the writer on July 10, 1957. The four materials were cleaned by a brush and placed in a glass bottle containing about 50 cc of sea water. About five hours after the bottle containing the animals were filled with sea water, two liberated eggs were found on its

1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 239.

2) The Japanese name is Ezotamakibigai.

3) On September, 1957, Dr. Tadashige Habe, of the Amakusa Marine Biological Laboratory of the Kyushu University at Amakusa, Kumamoto Prefecture, Japan, informed to the writer that new genus must be created by this species basing upon the reproductive type mentioned in the present paper.

bottom.

OBSERVATION

The egg capsule is colorless, transparent and of disk-shape. The capsule is about 880 μ in diameter and about 170 μ in thickness, and consists of two parts, the outer thin and wide peripheral brim and the inner lens-shaped part. The brim is a wide wheel with the same thickness being about 100 μ in width, and about 20 μ in thickness. The inner lens-shaped part is about 680 μ in diameter and about 170 μ in thickness at the central part. The capsule is bilaterally symmetrical on the axis of the brim in side view (Fig. 1). The 14 eggs counted in the capsule were arranged on the same central plane of the brim. The egg is about 95 μ in diameter and is covered by a thin membrane about 115 μ in diameter. The granules of the egg are white and red in color. The wall of the capsule is comparatively thick and solid.

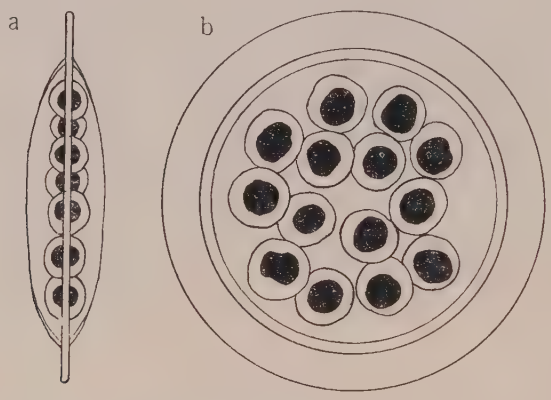

Fig. 1. The egg and capsule of *Littorina squalida* Broderip et Sowerby. ×57.
a : Side view. b : Viewed from above.

CONSIDERATION

Hirase (1927) and Kuroda (1955) described that *Littorina* (*Algaroda*) *squalida* Broderip et Sowerby is oviparous, but they did not described the structure of the egg. According to the observation of the writer the planktonic capsule of the egg of this species is disk-shaped and is of bilaterally symmetrical form in side view. According to Lebour (1935) *Littorina littorea* L. liberates helmet-shaped planktonic eggs. Tokioka and Habe (1953) classified the egg capsule of Littorinidae into following three groups, 1. Helmet-shaped, 2. Simple drum-shaped, 3. Drum-shaped, with ridges on the swollen upper side. The shape of

the egg capsule of this species is not found in their three groups of Littorinidae. The special characters of the egg capsule of this species which has a large and symmetrical shape, and which contains more eggs than the other species, show that the egg capsule of this species is a new type of the Littorinidae.

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CONTENTS

PAGE

YAMAMOTO, G. and T. HABE Fauna of shell-bearing mollusks in Mutsu Bay. Lamellibranchia (1). 1

HIRAI, E. Morphological observations of ascidian larvae. 4. *Styela plicata* (Lesueur). 21

HIRAI, E. On the species of *Cladonema radiatum* var. *mayeri* Perkins. 23

HOSHIAI, T. Synecological study on intertidal communities. I. The zonation of intertidal animal community with special reference to the interspecific relation. .. 27

KOJIMA, Y. On the breeding of a periwinkle, *Littorivaga athana* (Dall). 35

KOJIMA, Y. A new type of the egg capsule of a periwinkle, *Littorina squalida* Broderip et Sowerby. 39

TSUBATA, B. Oceanographical conditions observed at definite station off Asamushi during 1956. 43

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